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LESSONS LEARNED AND APPLICATIONS TO
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MATERIAL PROTECTION, CONTROL, AND ACCOUNTING UPGRADES IN AN FSU FACILITY: LESSONS LEARNED AND APPLICATIONS TO FUTURE USE

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ABSTRACT

In 1994, American and Ukrainian nuclear safeguards and security experts began to collaborate to improve the protection, control, and accountancy of nuclear materials at the research reactor of the Kiev Institute for Nuclear Research (KINR). Together we have met a number of challenges arising from the infancy of the Ukrainian state, the distance between us, our cultural and philosophical differences concerning stewardship of nuclear materials, and the difficult economic circumstances in Ukraine. The result of this collaboration is that all nuclear material at KINR is now reliably controlled and maintained under adequate protection from unauthorized access to it. Since October 1997, the physical protection system at KINR's research reactor has sustained a continuous and positive record of operation. In addition, a Training Center for the Protection, Control, and Accounting of Nuclear Materials has been established at KINR.

I. INTRODUCTION

Prior to Ukraine's proclamation of independence on August 24, 1991, the Parliament of Ukraine in the declaration of its sovereignty on June 16, 1990 had pledged that Ukraine would follow three non-nuclear principles: not to accept, not to produce, and not to acquire nuclear weapons.

The Parliament of Ukraine adopted the statement of non-nuclear status on October 24, 1991. Paragraph 3 of this statement reads: "Ukraine will pursue a policy directed to eliminate all nuclear weapons and their components from its territory. Ukraine intends to implement this policy rapidly, taking into account legal, technical, financial, administrative, and other issues, properly ensuring ecological safety." Paragraph 7 of the statement says:

"Ukraine intends to accede to the Nonproliferation Treaty as a non-nuclear weapons state and to conclude an appropriate Safeguards Agreement with the International Atomic Energy Agency (IAEA)." At that time, Ukraine held the third-largest store of nuclear weapons in the world, after the United States and the Russian Federation.

On November 18, 1993, the Parliament of Ukraine adopted a Decree "About the ratification of the Treaty between the United States of America (USA) and the Union of Soviet Socialist Republics (USSR) on the Reduction and Limitation of Strategic Offensive Arms, signed in Moscow on July 31, 1991 and the Lisbon Protocol signed by Ukraine on May 23, 1992." Finally, in 1994, the Parliament of Ukraine adopted a law "About the adherence of Ukraine to the Nuclear Weapons Nonproliferation Treaty of July 1, 1988." Paragraph 6 of this Law stipulated that it would enter into effect when Ukraine received "guarantees of protection by nuclear weapons states via properly signed appropriate international legal documents."

On February 8, 1995, the Parliament of Ukraine adopted the "Law on Utilization of Nuclear Energy and Radiation Safety," which created the legal framework for the peaceful use of nuclear energy in Ukraine.

On September 21, 1995, the "Agreement between Ukraine and IAEA on Nuclear Energy applying IAEA Safeguards in connection with Nuclear Weapons Nonproliferation Treaty" was signed in Vienna. The Agreement was ratified by the Ukrainian Parliament on December 17, 1997.

Thus, in a short period of time all provisions of Ukraine's declaration of its status as a non-nuclear weapons state were realized.

II. PROGRESS IN COLLABORATION

Most of the nuclear industry's infrastructure in the former USSR was located within the borders of the present Russian Federation. The Soviet nuclear industry was managed centrally from Moscow, with little local control. With the collapse of the USSR, operating nuclear power plants (NPP) remained in Ukraine with no national authority or regulatory framework to manage them. For the first time in history, a State's nuclear infrastructure had appeared earlier than its birth. Despite huge administrative, technical, and financial difficulties, the new Ukrainian government was forced to create promptly the regulatory and administrative bodies of its nuclear authority and the infrastructure necessary for its activity.

Operators of NPPs were very interested in creating their own scientific and technical safety operations supervision. The National Science Center Kiev Institute for Nuclear Research of the National Academy of Sciences (KINR) was one of but a few scientific organizations in Ukraine that had NPP experience.

KINR possesses a Soviet WWR-M research reactor, which was commissioned in February 1960. This reactor uses fuel enriched to 36% in the ^{235}U isotope. It also has fuel rods of 90%-enriched uranium and a small amount of uranium in bulk form. During the first years of independence, KINR received the attention of inspectors from Ukrainian regulatory bodies and the IAEA. Requirements suddenly had increased but the Institute's severely limited budget did not permit addressing them. Significant financial resources were required in order to install modern nuclear material protection, control, and accounting (MPC&A) systems to help secure nuclear material at the nuclear reactor.

A. Bilateral Agreements

With this financial situation in mind, the Ukrainian Ministry of Foreign Affairs signed the "Agreement between the USA and Ukraine Concerning Assistance to Ukraine in the Elimination of Strategic Nuclear Arms and the Prevention of Proliferation of Weapons of Mass Destruction" on October 25, 1993. This agreement, called hereinafter the Umbrella Agreement, established the legal framework for cooperation between the USA and Ukraine on the "establishment of measures against the proliferation of nuclear weapons from Ukraine, and technology and expertise related to such weapons."

On December 18, 1993, the "Agreement between Department of Defense of the USA and the Ukrainian State

Committee on Nuclear and Radiation Safety Concerning the Development of State Systems of Control, Accounting, and Physical Protection of Nuclear Materials to Promote the Prevention of Nuclear Weapons Proliferation from Ukraine" was signed in Washington, D.C. Hereinafter called the Implementing Agreement, this document defined the ways and means by which the objectives of the Umbrella Agreement would be met with regard to MPC&A. The United States Department of Energy (DOE) was designated as the implementing agency for the USA.

B. Bilateral Technical Working Group

Shortly after the Implementing Agreement was signed, a technical working group was composed of representatives of different organizations from Ukraine and the USA. At an April 15-19, 1994, meeting in Kiev and at a follow-up meeting on May 31 - June 4, 1994, in Washington, D.C., the technical working group selected nuclear sites in Ukraine at which MPC&A upgrades would be performed. The KINR and the South Ukraine NPP were designated model sites for MPC&A upgrades. It was agreed that the National Science Center Kharkiv Institute of Physics and Technology and the Sevastopol Naval Institute (now the Institute of Nuclear Energy and Industry) would be considered for subsequent upgrades. Agreements to proceed with upgrades at these facilities were finalized in 1995.

Groups of physical protection and material control and accounting (MC&A) specialists from Argonne, Sandia, and Los Alamos National Laboratories visited KINR in September-October, 1994. They observed the safeguards and security systems in place at the WWR-M research reactor, interviewed the staff, and reviewed procedures. The American team then used the information they obtained to analyze the systems of MC&A and physical protection and to develop detailed lists of upgrade recommendations and preliminary designs to review with their Ukrainian counterparts.

C. Physical Protection System Upgrades

A delegation of Ukrainian physical protection specialists visited the USA on November 30 - December 7, 1994 to examine physical protection measures applied to nuclear material at Sandia National Laboratories, the Waterford NPP, and Argonne National Laboratory. At that time there were no Ukrainian guidelines on the physical protection of nuclear material. The technical working group decided to adopt the American threat concept for protecting nuclear material, using both 10 CFR 73.1 and the IAEA's INFCIRC/225, Rev.3, as guidelines. This

decision expedited the installation of the MPC&A system at KINR's research reactor.

By the end of June 1995, a physical protection system design had been jointly developed, agreed upon, and documented. DOE designated Sandia as the lead laboratory to manage the implementation of the design. The project was coordinated with the appropriate regulatory, licensing and inspection bodies in Ukraine.¹⁻³

Sandia's proposal to subcontract the installation and integration of the physical protection systems to the Advantor Corporation (USA) was approved by Ukraine. By then the American experts, the specialists from KINR, and employees of the State Committee on Nuclear and Radiation Safety in Ukraine had reached a complete understanding on a design concept. In September 1995, the project met an obstacle when it was realized that Advantor's Ukrainian subcontractor was unlicensed to carry out work on nuclear facilities. The impasse was resolved when a proposal to use the KINR experts as subcontractors was accepted.

By late summer 1997, the physical protection upgrades at the research reactor were nearing completion and Advantor had begun to train the staff in operating and maintaining the systems. The MPC&A systems at the reactor were placed into operation on October 21, 1997, and have been operated continuously ever since. By a decree of the Ukrainian government, the facility is guarded by a special unit of the Ministry of Internal Affairs of Ukraine. The Ukrainian government provides funding for these operations. A joint (Ukrainian and American) commission of experts performed a thorough acceptance test of the reactor's Physical Protection System prior to its commissioning.

D. Material Control and Accounting Upgrades

Along with the physical protection upgrades, USA MC&A experts collaborated with their KINR counterparts to identify and install appropriate equipment to provide for improved control and accounting of the nuclear material located at KINR.⁴ The Institute was provided with nondestructive assay equipment, computers, and software. Experts at KINR collaborated with USA specialists to develop an Automated Inventory/Material Accounting System (AIMAS) that provides for physical inventory tracking, transaction histories, reporting, and system administration functions.⁵

E. Customs Hurdles

Hurdles were encountered upon the attempted delivery of the first shipments of materials and equipment from the USA. This was during the early years of the Ukrainian Customs Service, and their regulations were under constant flux. Cargos sometimes were stored for periods of months while they awaited customs clearance. Because of its location in Kiev and ready access to government officials, KINR coped with this problem more effectively than facilities more remote from the center of government. To resolve customs logjams, KINR appealed as necessary to the Ministry of Environmental Protection and Nuclear Safety of Ukraine (and its predecessor the State Committee on Nuclear and Radiation Safety), the Cabinet of Ministers, and even the office of the Vice-Premier. On June 25, 1996, Vice-Premier V. Durdinets issued an order authorizing the State Customs Committee and the Ministry of Environmental Protection and Nuclear Safety (MEPNS) to coordinate receipt and customs clearance of cargoes delivered under the aegis of the Umbrella and Implementing Agreements. Even at that, there were a few subsequent instances in which appeals to higher Ukrainian authorities were necessary in order to facilitate the customs clearance of MPC&A shipments.

F. Training

One of the most important goals of the program is to improve the safeguards and security culture by providing pertinent training to Ukrainian MPC&A specialists. The responsibilities for providing this training have fallen upon the staffs of both the KINR and DOE's national laboratories. KINR MPC&A experts have been involved in the MPC&A training from the very beginning. The earliest courses included the fundamentals of physical protection and nuclear material control and accounting. At first, KINR simply hosted the courses while American experts delivered the training. Beginning in 1997, KINR and MEPNS lecturers delivered certain sections of the courses. KINR experts compiled training materials delivered by the American side and used them to prepare student manuals in Russian. Among the courses for which Russian-language student manuals were prepared are:

1. Physical Protection System Design
2. Vulnerability Assessment
3. Accounting and Control of Nuclear Material
4. Advanced Statistics and Measurement Control.

Early participants in the training courses included experts from Ukrainian NPPs, employees of the Nuclear Regulatory Authority, specialists from scientific institutions who have nuclear material at their disposal, and representatives of the Ministries and Departments working in the field of a nuclear energy. The caliber and methodology of the training were highly appreciated by the Ukrainian authorities and course participants.

Such was the success of these training courses that, on September 3, 1997, the Prime Minister of Ukraine issued an order delegating to KINR the "organization and realization of continuing education for experts in Accounting, Control, and Physical Protection of Nuclear Material and nuclear facilities and to apply foreign assistance for training Ukrainian MPC&A professionals." This order was initiated by the National Academy of Sciences of Ukraine, the Ministry of Environmental Protection and Nuclear Safety, the Ministry of Energy, the Ministry of Industrial Policy, the Ministry of Science and Technology, the Ministry of Emergencies, the Ministry of Transportation, the Ukrainian Customs Service, the Ministry of Internal Affairs, the Security Service of Ukraine, and the State Committee on Export Control. Thus, the creation of an MPC&A training program at KINR was supported by virtually all Ministries and Departments of the Ukrainian government.

G. Training Center

DOE and KINR representatives had reached an agreement on March 17, 1997, to study the possibility of creating at KINR a Training Center for Physical Protection of Nuclear Material Control and Accounting and to develop a preliminary design for it. The design called for demolition of the ground floor of one end of a wing of the KINR administration, followed by new construction therein. Pursuant to the Prime Minister's order, designs were finalized and construction began in October 1997. Sandia National Laboratory experts supervised the Training Center construction and Argonne provided the necessary equipment.

By the time construction on the Training Center commenced, the Ukrainian and American team of experts had forged a strong, effective working relationship. They had accumulated significant experience with expediting Customs clearance and with procuring necessary materials, equipment, and services. Despite this experience, numerous obstacles appeared during the Training Center construction project.

Once again, the Customs Service of Ukraine refused release of a major shipment of construction materials and

electrical and mechanical equipment without payment of customs duties because, in their judgment, this cargo did not meet the exemption criteria spelled out in the Umbrella Agreement. The confusion was attributable to the fact that Sandia had subcontracted the actual construction work to a Ukrainian-British company, who in turn was attempting to import the equipment and materials needed to complete their work. Only when the Nuclear Regulatory Authority and the Cabinet of Ministers of Ukraine took a firm stance did the Customs Service relent.

The task of furnishing and equipping the Training Center brought additional challenges. This work was executed by KINR under a contract with Argonne. Working with a fixed budget, the KINR staff painstakingly selected the equipment and furnishings needed for the Center. By the time the funds for procurement were finally transferred from the USA, the Russian economic meltdown had occurred. This had a deleterious effect on the exchange rate for the Ukrainian national currency. The Ukrainian suppliers presented invoices for payment based on an exchange rate that devalued the hryvna more than did the exchange rate of the National Bank of Ukraine. For a time, it appeared unlikely that the Training Center would be fully equipped. With very careful shopping, however, it was possible to provide the Center with the necessary furnishings and equipment, staying within the budget.

The Training Center occupies an area of 420 square meters that includes: two classrooms that seat 50 students each; a computer laboratory that accommodates 20 participants; a staff meeting room; a library; staff offices; restrooms; and a small kitchen in which to prepare snacks for course breaks. It is equipped with computers, high-resolution printers, photocopiers, a flat-bed scanner, and binding devices for preparing training materials. There are standard overhead, computer, and video projectors for use in presentations. To provide for efficient communications between the training center staff and their American collaborators, facsimile transmission and internet capabilities have been installed. The close proximity of the George Kuzmycz MPC&A Training Center to KINR's research reactor provides excellent opportunities to use its upgraded MPC&A systems for teaching demonstrations and practical exercises.

A full-time staff has been employed to organize, prepare, and present courses at the Training Center. They attended a special course in training administration and curriculum development techniques at Sandia in October 1998. Adjutant staff members from KINR, MEPNS, and other organizations have been identified for employment in courses wherein their specific expertise is required.

III. OBSERVATIONS AND CONCLUSIONS

1. Provision of modern equipment and training has resulted in significant improvements in KINR's MPC&A systems and eased the transition to an IAEA safeguards inspection regime so successfully that IAEA inspectors have found it necessary to make very few substantive corrective remarks.
2. Training provided at KINR to Ukrainian MPC&A specialists has resulted in an overall improvement in Ukraine's culture of nuclear safeguards and nonproliferation. To date, more than 400 Ukrainian experts have elevated their qualifications by participating in these courses.
3. The creation of the Training Center has led to a significant improvement in the base professional training skills of its staff.
4. Training materials delivered by the USA have facilitated the development of training manuals for Ukrainian experts in the fields of nuclear material accounting and control, nondestructive analysis of nuclear material, and physical protection fundamentals.
5. KINR gained valuable experience in carrying out international projects.
6. Experience gained by the American experts in the course of completing the MPC&A upgrades at KINR was successfully used at other nuclear sites in Ukraine.

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We must gratefully acknowledge the immeasurable contributions made by the DOE's MPC&A program manager for Ukraine, the late George Kuzmycz. His untimely death in an automobile accident in southern Ukraine in December 1997 was a great loss to us. From the beginning of our collaboration, Kuzmycz realized and appreciated the capabilities of the KINR specialists and gained their immense respect. Thanks largely to his outstanding personality, his energy, and his resourcefulness, all KINR tasks planned in accordance with the Implementing Agreement were completed successfully and expeditiously. With his fluency in the Ukrainian language and his understanding of the Ukrainian people and culture, Kuzmycz was uniquely capable to foster understanding between the specialists of both countries and to make their joint work successful and beneficial. As a result, lasting friendships between

specialists on both sides were formed. It was only natural to commemorate Kuzmycz's great influence on our lives and our work by giving the Training Center his name. On October 8, 1998, the Ministry of Environmental Protection and Nuclear Safety of Ukraine and the National Academy of Sciences of Ukraine, in the presence of Kuzmycz's family, friends, and colleagues, were pleased to commission the George Kuzmycz Training Center for Physical Protection, Control, and Accounting of Nuclear Material.

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